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Emergency Pedal Artery Bypass Grafting

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Objectives. *To determine the value of emergency pedal artery bypass.*
Material and Methods. *Data were drawn from a prospective vascular database. Inclusion criteria were: acute onset of critical forefoot ischemia, emergency surgery, no pre-operative angiographic imaging of the pedal vasculature and attempted revascularisation of a pedal vessel.*
Follow-up was obtained from outpatient records. The grafts were considered patent if a pedal pulse was palpable.
Results. *Eight out of 208 pedal vascular procedures performed between January 1996 and June 2002 were entered into the study. This cohort consisted of 3 women and 5 men (age 23–85 years, median 71). Operations were performed because of thrombo-embolic occlusion of the tibial vasculature (5 patients), severe tibial embolism following a percutaneous angioplasty of the superficial femoral artery, trash foot following aortic reconstruction and acute occlusion of tibial run-off vessels following a crural reconstruction. Two patients suffered an early graft occlusion, one of them resulting in major amputation. At a median follow up of 17 months (10–52 months) the remaining 6 grafts were patent.*
Conclusions. *If catheter directed methods (local lysis, aspiration embolectomy) or surgical procedures (embolectomy, tibial bypass) fail to treat critical foot ischemia, pedal probatorial dissection and pedal bypass is worthwhile.*

Key Words: Arterial occlusive disease; Acute critical limb ischemia; Pedal artery bypass.

Introduction

Pedal artery bypass has evolved into a feasible technique in the treatment of chronic foot ischemia. In particular, diabetic patients benefit from these peripheral vascular procedures.[1,2] Less data exists about the results of pedal artery grafting in case of acute onset of peripheral ischemia, thus, this analysis of prospectively collected data aimed at determining the value of emergency pedal artery bypass.

Material and Methods

The setting of this study was the department of vascular surgery of a tertiary referral centre. Data were drawn from a prospective database, which includes all vascular procedures performed at the institution since 1995.

Inclusion criteria to enter this analysis were: acute onset of critical ischemia at least at the forefoot level (category II b according to the recommended standards for reports dealing with lower extremity ischemia[3]), emergency surgery, no adequate pre-operative angiographic imaging of the pedal vasculature and attempted revascularisation of a pedal run-off vessel.

Surgical technique

Patients were seen as candidates for emergency pedal probatorial dissection if pre-operative physical examination or recent angiographic studies (in cases of re-occlusions of former reconstructions) demonstrated an undisturbed inflow at the popliteal level and an on-table angiogram (performed by injecting contrast agent into the third popliteal segment) did not demonstrate a tibial artery that would supply adequate perfusion of the ischemic forefoot (i.e. no continuous named vessel and no collateral vessels) or a pedal target vessel.

Reasons to exclude a patient from acute pedal revascularisation were severe concomitant disease (coronary, pulmonary, malignant), non-ambulatory

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status and severe ischemia of the entire forefoot lasting more than 48 h.

Exploratory dissection of the pedal vasculature was started in the retromalleolar region (including the retromalleolar artery and the medial and lateral plantar artery) and continued at the dorsum of the foot if the retromalleolar arteries were unsuitable for surgery. The pedal vessels were exposed by longitudinal incisions. Run-off was assessed by means of exploratory arteriotomy or intraoperative angiography. For the latter the artery was punctured in retrograde direction using a canula with a diameter of 0.8 mm (Venflon, Becton Dickinson; Helsingborg, Sweden) and non-ionic contrast material (Visipaque—Amersham Health AS, Oslo, Norway) was injected under fluoroscopy. The decision to perform selective intraoperative angiography of a pedal artery was at the discretion of the surgeon and depended mostly on the grade of vessel calcification. In case of arteriotomy, the peripheral resistance was evaluated by injecting heparin–saline solution. Back bleeding was controlled intraluminally using a 2 French Fogarty catheter (Edwards Lifesciences LLCC, Irvine, CA). Autologous bypass material was used in all cases. The grafts were kept as short as possible. Anastomoses were done end-to-side using continuous sutures (6/0, 7/0 Prolene—Ethicon GMBH, Norderstedt, Germany). A final intraoperative angiography was performed on each patient. All surgeons used either surgical loupes (3,5 × extended view, Designs for Vision, Inc., Ronkonkoma, NY) or a dynamic magnification system (Varioscope® AF 3, Life Optics GmbH, Vienna, Austria). In order to prevent wound complications at the forefoot, the ankle joint was immobilised with a plaster cast until wound healing.

Follow-up

The patients were first seen 6 weeks after discharge and at 3-month intervals thereafter. The grafts were considered patent if an obvious pedal pulse was palpable. In uncertain cases duplex scanning was used to confirm patency.

Results

Two hundred and eight pedal artery vascular procedures (15 pedal exploratory dissections of vessels that turned out to be chronically occluded and 193 pedal bypass reconstructions) were registered between January 1995 and July 2002 (Table 1). Eight patients—3 women and 5 men, median age 71 years

Table 1. Type and indication of 648 infra-popliteal vascular procedures performed for peripheral occlusive disease between January 1995 and July 2002.

	Kind of procedure (primary-30 days-patency)					
	Selective tibial embolectomy	Tibial bypass	Tibial exploratory dissection	Pedal bypass	Pedal exploratory dissection	Local lysis
Acute critical limb ischemia	45 (82.2%)	103 (73.7%)	4	8 (75%)	0	63(74.6%)
Chronic critical limb ischemia	0	211(90.9%)	14	183 (96.1%)	15	0
Total	45	314	18	193	15	63

The primary (30 days) patency of each procedure is given in brackets.

(range 23–85 years) had pedal artery bypass because of the acute onset of limb threatening ischemia and met the inclusion criteria of this analysis. During the same period 17 patients suffered major amputation because of acute critical limb ischemia.

Table 2 demonstrates the indication for pedal revascularisation, number and type of previous procedures and the type of pedal revascularisation performed.

Patient 1 suffered severe tibial embolism during a percutaneous angioplasty of the superficial femoral artery. Local lysis (20 mg recombinant tissue plasmin activator (rt-PA) and 100,000 units urokinase) and embolectomy of the peroneal artery were not successful, and the limb was finally revascularised by extending a popliteal bypass down to the pedal level. One 80-year old man (patient 2) was admitted with complete ischemia of the entire leg. He had a history of contralateral major amputation and an ipsilateral thrombosed popliteal aneurysm. He had suffered ischemic rest pain for months. An angiogram performed 2 months before admission in another hospital demonstrated a patent superficial femoral artery but no potential tibial run-off vessel. The digital subtraction angiography at the time of admission demonstrated an (obviously recent) occlusion of the superficial femoral artery and non-filling of the entire vasculature below knee level (Fig. 1). Revascularisation consisted of a thrombectomy of the superficial femoral artery and a vein graft to the plantar artery (Figs. 2 and 3).

Four patients (patients 3, 4, 7 and 8) had an acute onset of ischemia due to thrombo-embolic occlusion of the tibial vasculature. In all cases, catheter directed local lysis (250,000 units to 1,250,000 units of urokinase) was unsuccessful and a pedal graft was finally used to restore a pulsatile flow to the ischemic foot.

Patient 5 suffered severe trash foot ischemia immediately after an aortic reconstruction. Selective thrombectomy of the tibial vasculature failed and the foot was finally revascularised by a popliteal–pedal vein graft. One 74-year old male (patient 6) had early occlusion of a tibial graft due to a partially thrombosed run-off vessel. In this case exploratory dissection demonstrated a graftable retromalleolar artery and the reconstruction was extended to the pedal level.

The operating times in this series ranged from 125 to 270 min (median 185 min). None of the patients had a complete pedal arch as assessed by post-reconstruction angiography, four demonstrated partial filling of the pedal arch (Table 2).

We encountered two early graft failures (patients 5 and 6), one of them resulting in a major amputation. Long lasting therapy with prostanoids (21 days) and beta-blockers was successful in preserving the leg in the second case. The remaining six grafts remained patent, with follow-up ranges from 10 to 52 months (median 17 months).

Discussion

According to the current literature there is no evidence to favour either surgery (selective embolectomy, tibial bypass grafts) or local thrombolysis in the case of acute thrombotic occlusion of the infra-popliteal arteries.[4–6]

The latter is associated with hemorrhagic complications and a higher risk of ongoing ischemia. Local lysis can be time-consuming and thus may be contra-indicated if the patient suffers complete ischemia with paralysis and severe rest pain. Distal embolisation of thrombus fragments or atherosclerotic debris may lead to occlusion of the more distal portion of the tibial vasculature, causing further deterioration of the forefoot.

Selective embolectomy of the crural arteries, performed via an arteriotomy in the third popliteal segment, causes damage to the intimal layer and sometimes results in prolonged spasm of the vessel, leading to early re-occlusion. If the tibial vasculature is affected by recurrent embolic events or multiple Fogarty manoeuvres, bridging the affected vascular territory can be necessary.

Although it is a procedure rarely performed, pedal artery grafting can be the only solution in such cases where the above mentioned methods have failed.

Due to limited blood flow in the ischemic area, in case of acute complete ischemia contrast-related methods (DSA, CE-MRA) can miss potential pedal target vessels. Highly sensitive duplex scan using 13 MHz probes is another means to evaluate the pedal vascular territory. Due to limited facilities (no angiologist on call at night) duplex was not been used in this series of acute ischemic patients.

Patients suffering complete lower leg ischemia will need surgery—at least a major amputation if revascularisation fails. Thus, it seems worthwhile to transport these patients directly into the operating theatre instead of time consuming diagnostic work-up. If on-table angiography via the third popliteal segment does not depict target vessels supplying a sufficient blood flow into the forefoot, exploratory dissection of the pedal vessels, quickly and easily determining the patency of the pedal vasculature, is definitely worthwhile.

In addition to surgical skills (microsurgical techniques, optimal visualisation, endo-luminal bleeding-control) pedal revascularisation demands

Table 2. Indication for emergency pedal artery bypass, number and kind of previous procedures, location of the proximal and distal bypass anastomosis, run-off via the pedal arch and follow-up.

Pt. nr., sex/age	Indication for pedal bypass	Number and kind of previous procedures		Prox. anast.	Dist. anast.	Pedal arch (score 0–II)	Follow-up (months)	
1, M/64	Re-occlusion of peroneal graft	4	PTA SFA, local lysis	Pop. graft	DPA	0	52	Patent
			Embolectomy, popliteal bypass, local lysis					
	Acute crural ischemia		Femoro-peroneal graft, local lysis					
			Graft revision, local lysis					
2, M/85	Acute leg ischemia	0		SFA	Plant A	I	13	Patent
3, F/23	Acute lower leg ischemia	2	Local lysis	Pop III	RMA	I	0	Occl.
			Tibial thrombectomy, local lysis					
4, F/84	Recurrent tibial embolism	1	Tibial thrombectomy, local lysis	Pop III	DPA	I	0	Occl.
5, M/68	Trash foot following AAA resection	1	Tibial embolectomy	Pop III	Plant A	0	21	Patent
6, M/74	Early occlusion tibial graft	1	Popliteo-tibial bypass	Pop III	RMA	I	19	Patent
7, F/85	Recurrent tibial embolism	2	Aspiration-embolectomy	Pop III	RMA	0	10	Patent
			Embolectomy, local lysis					
8, M/28	Acute tibial ischemia	3	Tibial embolectomy, local lysis	Pop III	RMA	0	10	Patent
			Re-embolectomy, lysis					
			Re-lysis					

SFA, superficial femoral artery; Pop III, third popliteal segment; DPA, dorsal pedal artery; RMA, retromelleolar artery; Plant A, plantar artery. Pedal arch score 0 = occluded. Pedal arch score I = incomplete. Pedal arch score II = complete.

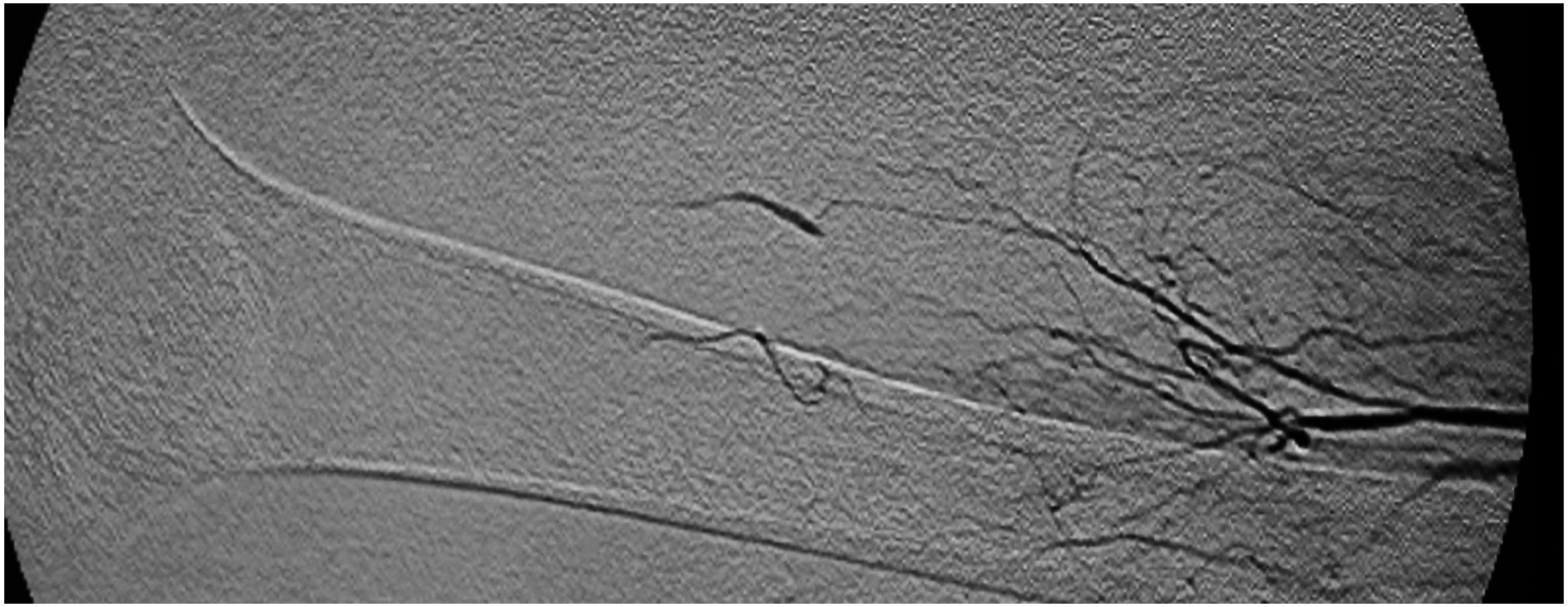

Fig. 1. Acute occlusion of the superficial femoral artery with non-filling of the peripheral part of the thigh (Patient 3).

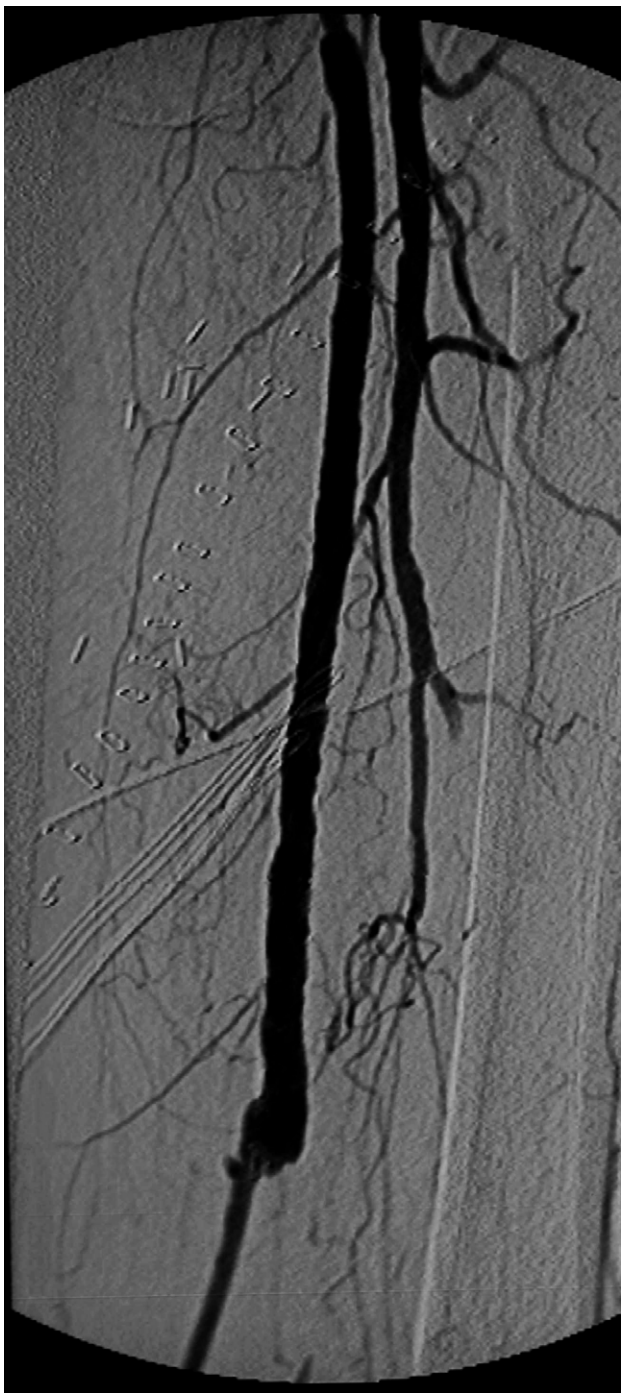

Fig. 2. Angiographic control following thrombectomy of the superficial femoral artery and femoro-pedal bypass—proximal anastomosis (Patient 3).

Fig. 3. Distal anastomosis of a femoro-pedal bypass (Patient 3).

for an optimal patient selection.[7] Especially wound complications at the forefoot may lead to erosive bleeding at the distal bypass anastomosis and consequent major amputation.[8] Thus we took care not to create large skin flaps at the forefoot and we excluded patients with impending skin necrosis at the forefoot from pedal bypass surgery.

The results of our small series dealing with pedal reconstructions in patients with acute severe ischemia and impending major amputation were satisfying and did not differ from the other methods we have used to treat acute critical limb ischemia. Thus patients suffering limb threatening ischemia based on infrapopliteal acute arterial occlusions can be given this chance of revascularisation if other therapeutic approaches fail.

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